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To test the efficacy of inquiry development materials with the gifted, six 7th-graders with IQ's in the top 3% participated in an inquiry science class with specially selected materials twice a week for 40 minutes over 6 months; six children with like IQ's worked on science activities in another room. Pre- and posttests in critical thinking and science achievement were administered; in addition, measures of inquiry and analyses of student questions and teacher interaction were made. Results indicated that the students in the inquiry class asked significantly more questions relating to experimentation and that the teacher, while in the inquiry class, was significantly more likely to clarify pupil questions and to respond to pupils seeking data than he was with the conventional class, to whom he provided data. Other results were nonsignificant, thus failing to provide evidence for noticeable improvement in the area of inquiry. (JD)

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FINAL REPORT

THE APPROPRIATENESS OF INQUIRY DEVELOPMENT MATERIALS FOR GIFTED SEVENTH GRADE CHILDREN

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June 1969

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Richard C. Youngs
William W. Jones

June 1, 1969

PART ONE

THE PROBLEM

Introduction

This research study is to a degree a replication of a study conducted by J. Richard Suchman titled "The Elementary School Training Program in Scientific Inquiry." The present study differs from the one done by Dr. Suchman in that it addresses itself to Junior High aged gifted children and assesses the appropriateness of inquiry development for this population.

In that much of the detail and background described in Dr. Suchman's report (1962) is also germane to this study, the authors have elected to provide only a brief description of that information. We suggest anyone finding the description inadequate refer to Dr. Suchman's report.

Statement of the Problem

The purpose of this investigation has been to test the efficacy of Inquiry Development Materials for gifted children. It is important that the value of these materials be established because this program, and more generally the theory of inquiry, is frequently being prescribed for the instruction of gifted children. There is little evidence, however, to support such prescriptions for these children.

On the other hand, many teachers and authorities in the area of gifted education suggest that inquiry development is a technique which should be considered for gifted children. (Gallagher, 1966; Suchman, 1961; Bruner, 1961; and Blackwood, 1955)

Definition of Terms

In this study we have defined gifted children as those children who have an intelligence score in the top 3% of the normal population as measured by the Binet Intelligence Scale.

Inquiry as defined by Suchman (1962) is "A way to investigate causation." The Inquiry Development Program is a sequence of instruction developed by Dr. Suchman which purports to teach children an effective mode of inquiry.

History of Inquiry Development

Dewey (1910) suggested that the encouragement of the scientific method in elementary schools would develop modes of logical thinking in children. Dewey saw as an additional advantage of the scientific method the preservation of curiosity within young children.

Others have described inquiry in terms of curiosity. "At the prime and perhaps almost the most profound level of the inquiry is the exercising of curiosity" (Never 1966)

Description of The Inquiry Development Program

The inquiry development program is based on the concept that curiosity can be used to motivate children and bring about significant learning activities. The program presents to the children a variety of inquiry problems (Table 1.1). These problems are designed to stimulate the child's curiosity. His curiosity compels him to search for meaning and a resolution of the inquiry problem. The problems are presented in a variety of ways including teacher-led and child conducted demonstrations along with films, pictures, and diagrams.

When questions are asked of the teacher the teacher is permitted to answer only "Yes" or "No." This avoids the temptation to provide

children with explanations and limits the teachers' responses to information requested by the child.

TABLE 1.1

Inquiry Problems Used in This Experiment

Problem	Type	Title
1	Film 1	The Stalled Car
2	Demonstration	Car on a Slope
3	Demonstration	Blocks on a Slope
4	Film 2	The Cannon
5	Idea Book Problem	Fluid Poured at an Angle
6	Demonstration	The Spinning Bucket
7	Film 3	The Baseball Catcher
8	Demonstration	The Siphon
9	Film 4	The Man and the Dumbbells
10	Demonstration	The Hanging Cardboard
11	Idea Book Problem	The Loop the Loop
12	Film 5	The Five Pendulums
13	Demonstration	Wood Sinks and Floats
14	Idea Book Problem	Period of a Pendulum
16	Film 6	The Ice Cubes
17	Demonstration	The Loose Lid
18	Film 7	The Balloon in the Jar
19	Demonstration	The U-Tube Manometer
20	Idea Book Problem	The Leaky Bucket
21	Film 8	The Restaurant
26	Film 10	The Spring Carts
31	Film 12	The Sailboat and the Fan
33	Film 13	The Wrenches
35	Demonstration	Weight of Object in Air and Water
37	Demonstration	The Pulse Glass
39	Film 15	The Knife
41	Film 16	Drinking Boiling Coffee
53	Film 21	The Eight Pendulums
56	Film 22	Boiling by Cooling
64	Idea Book	The Melting Ice

PART TWO

THE PROCEDURES

Introduction

The procedures used in the selection of the children, the carrying out of the experiments, and the analysis of data are described in Part Two.

Selection of the Children

The children for this experiment were selected from a group of seventh grade children in the Metcalf Laboratory School. Those selected had an intelligence score, on an individually administered Binet, in the top 3% of the normal population. The twelve children which participated in the study were randomly assigned to two groups of six children each. Both groups were then administered pre-tests which measured critical thinking and science achievement.

Instruction was carried out for approximately six months. Children participated in the inquiry class twice a week for forty minutes. The children who did not participate in inquiry class were permitted to work in another room on science activities. Following the instruction the children were administered post-tests in the area of science achievement and critical thinking. In addition, measures of inquiry were obtained along with an analysis of the types of questions the inquiry trained and the conventionally trained children asked in their respective classes. An analysis of teacher interaction was also made.

PART THREE

DATA AND ANALYSES OF DATA

Types of Analyses

Five types of analyses were made in this experiment. Pre and post tests were administered in the area of critical thinking (Test of Critical Thinking by M. J. Macy and Hugh E. Wood, University of Oregon) and Science Achievement (Cooperative General Science Test, Forms A & B, Educational Testing Service, Princeton, N. J.). Inquiry Test Films (Suchman, 1962), Evaluating Growth through Inquiry (Costa, et al), and A Classification of Teacher-Pupil Behaviors Relating to Inquiry Teaching Strategy (Costa, et al) were employed as post-test instruments.

Critical Thinking

Pre and post tests were administered for critical thinking. The results of these tests were summarized through an analysis of covariance which indicated no significant differences between the experimental and control groups (Table 3.1).

TABLE 3.1

Summary of Analysis of Covariance

Test of Critical Thinking

Source	Degrees of Freedom	Σx^2	Σxy	Σy^2	Σx^2_{adj}	Variance	F-Test	Probability
Among	1.	494.0	51.3	5.3	474.2	474.2	1.3	NS
Within	9.	3312.3	346.2	1902.4	3249.3	361.0		
Total	10.	3806.3	397.5	1907.7	3723.4			

Science Achievement

Pre and post tests were administered to both groups for science achievement. The results of these tests are summarized by an analysis of covariance. No significant differences were found between the experimental and control groups on this variable (Table 3.2).

TABLE 3.2

Summary of Analysis of Covariance

Cooperative General Science Test

Source	Degrees of Freedom	ΣX^2	ΣXY	ΣY^2	ΣX^2_{adj}	Variance	F-Test	Probability
Among	1.	-0.06	0.0	0.75	0.04	0.04	0.003	NS
Within	9.	223.75	260.50	709.50	128.11	14.23		
Total	10.	223.69	260.50	710.25	128.14			

Inquiry

Tables 3.3 through 3.7 summarize the analysis of data for the Inquiry Film Test. Five sub-scores resulted from the administration of this test. They are fluency, verification, experimentation, synthesis and quality. Because the Inquiry Film Test can be used only once it was omitted as a pre-test and used as a post-test necessitating an analysis of variance as a statistical procedure. The results of this analysis failed to reveal a significant F-Ratio for any of the variables herein listed (Tables 3.3 through 3.7).

TABLE 3.3

Summary of Analysis of Variance

Test Film I: Cartesian Diver

Fluency

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F-Ratio	P.
Among	18.8	1	18.8	0.1	NS
Within	1300.2	10	130.0		
Total	1318.9	11			

TABLE 3.4

Summary of Analysis of Variance

Test Film I: Cartesian Diver

Verification

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F-Ratio	P.
Among	3.0	1	3.0	0.0	NS
Within	1025.7	10	102.6		
Total	1028.7	11			

TABLE 3.5

Summary of Analysis of Variance

Test Film I: Cartesian Diver

Experimentation

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F-Ratio	P.
Among	21.3	1	21.3	0.4	NS
Within	511.7	10	51.2		
Total	533.0	11			

TABLE 3.6

Summary of Analysis of Variance

Test Film I: Cartesian Diver

Synthesis

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F-Ratio	P.
Among	2.1	1	2.1	0.2	NS
Within	96.2	10	9.6		
Total	98.3	11			

TABLE 3.7

Summary of Analysis of Variance

Test Film I: Cartesian Diver

Quality

Source	Sums of Squares	Degrees of Freedom	Mean Squares	F-Ratio	P.
Among	0.0	1	0.0	0.0	NS
Within	3.7	10	0.4		
Total	3.7	11			

Analysis of Questions Asked

The types of questions asked by both the experimental and control students in the conventional class and inquiry oriented class were examined. Three types of questions were observed (verification, experimentation, and synthesis) and their frequency compared by an analysis of variance.

Tables 3.8 through 3.10 summarize the types of questions asked by the experimental and control group while participating in a conventional class. Significance was not observed for any of these variables.

TABLE 3.8

Analysis of Variance

Types of Questions Asked in the Conventional Class

Verification

	N	Mean	S.D.
Experimental	6	2.83	2.67
Control	6	4.67	3.30

t = .966 (N.S.)

TABLE 3.9

Analysis of Variance

Types of Questions Asked in the Conventional Class

Experimentation

	N	Mean	S.D.
Experimental	6	0.33	0.47
Control	6	0.50	1.12

t = .307 (N.S.)

TABLE 3.10

Analysis of Variance

Types of Questions Asked in the Conventional Class

Synthesis

	N	Mean	S.D.
Experimental	6	2.17	2.61
Control	6	2.33	3.04

t = .093 (N.S.)

Tables 3.11 through 3.13 summarize the analysis comparing the questions asked by the inquiry-trained students in the experimental class with the non inquiry-trained students in the conventional class. Table 3.12 indicates significance at the .05 level suggesting that inquiry trained students engage in more experimentation activities in the inquiry class than do untrained students in a conventional class.

TABLE 3.11

Analysis of Variance

Types of Questions Asked in Experimental and Control Classes

Verification

	N	Mean	S.D.
Experimental	6	12.33	11.23
Control	6	4.67	3.30

t = 1.464 (N.S.)

TABLE 3.12

Analysis of Variance

Types of Questions Asked in Experimental and Control Classes

Experimentation

	N	Mean	S.D.
Experimental	6	8.00	7.96
Control	6	5.00	1.12

t = 2.086 (significant at .05)

TABLE 3.13

Analysis of Variance

Types of Questions Asked in Experimental and Control Classes

Synthesis

	N	Mean	S.D.
Experimental	6	5.50	4.07
Control	6	2.33	3.04

t = 1.394 (N.S.)

A Classification of Teacher-Pupil Behaviors Relating to the Inquiry Teaching Strategy

The data for this portion of the study was collected through transcripts of class sessions. The questions asked in selected class sessions were categorized and summarized into matrices. The following areas were examined within the matrices. (See Costa, et al., for total list.)

Matrix Areas Examined

Area 2 The teacher responds to a pupil's response and then structures.

Area 4 A pupil seeks data and the teacher responds by structuring.

Area 5 A pupil theorizes and the teacher responds by structuring.

Area 10 Pupil seeks data and the teacher provides data.

Area 11 Pupil seeks data and teacher seeks clarity of what pupil wants to know.

Area 14 Pupil theorizes and teacher seeks clarity of pupil's idea.

Area 18 Pupil seeks data and teacher initiates response to facilitate use of processes.

Area 21 Teacher structures and pupil seeks data.

Area 22 Teacher responds to pupil and pupil seeks data.

Area 27 The teacher structures and a pupil theorizes.

Table 4.14 lists the per cent of tallies found in selected areas of the matrices. For the conventional class, a noticeably higher percentage of tallies was found in area 4 (pupil seeks data and the teacher responds by structuring), area 5 (pupil theorizes and the teacher responds by structuring), area 10 (pupil seeks data and the teacher provides data), and area 21 (teacher structures and pupil seeks data). In the class instructed by the inquiry method a noticeably higher percentage of tallies was found in area 11 (pupil seeks data and teacher seeks clarity of what the pupil wants to know), and area 22 (teacher

responds to pupil and pupil seeks data).

TABLE 3.14

PER CENT OF TALLIES FOUND IN SELECTED AREAS OF THE MATRIX

Area*	Normal Class % of tallies	IPD Class % of tallies
2	3.	.7
4	5.5	.7
5	4.5	.7
10	33.	26.
11	1.7	12.
14	4.	1.
18	3.	0.
21	5.	.3
22	17.	35.
27	4.5	1.3

*See chart "Matrix Areas Examined" (Page 12)

The data summarized in Table 3.14 suggests that noticeably different behaviors are exhibited by students and teachers in the inquiry class when compared with the conventional class.

PART FOUR
CONCLUSIONS

Summary and Conclusions

With the exception of two measures, non-significant results were obtained in this study. The significant measures indicated that questions relating to experimentation were asked with greater frequency by students who participated in the inquiry classes than were asked by students participating in the conventional class. The second noteworthy result of the experiment was that teacher-pupil behavior differed in the experimental and control classes. In the experimental classes the teacher was more likely to clarify pupil questions and respond to pupils seeking data, while the same teacher in the conventional class provided data.

The results of this study are similar to the outcomes of previous studies (Youngs, 1967; Suchman, 1961, 1962; Scott and Segal, 1965) in which content and achievement gains were difficult to demonstrate and that evidence for noticeable improvement in the area of inquiry was lacking.

Suggestions for Further Study

Inquiry is an increasingly popular technique for teaching children. In light of the fact that this and previous studies have failed to demonstrate the effectiveness of the Inquiry Development Program, techniques need to be developed which can establish the effectiveness of the method. Decisions need to be made regarding the implementation or rejection of such a strategy based on substantive data rather than on impression or whim. Suchman (1969) suggests that relevant techniques for effective evaluation of the Inquiry Method have yet to be developed.

He further proposed a system of mapping, similar to the method used by Piaget, for examining changes in inquiry behavior. The outcome of this and previous studies suggests that the area of evaluation of the act of inquiry deserves considerably more study.

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